

IN THE CLAIMS:

Please amend the claims of this application so as to read as follows:

1. (Currently Amended) A rising and moving apparatus, comprising:

a body;

an elastically deformable wing portion associated with said body;

a driving unit for driving the wing portion; and

a control unit controlling the manner of driving the wing portion by the driving unit,

wherein

when driven by said driving unit, said wing portion is elastically deformed by a

surrounding fluid such that a ~~lifting~~ force including a lifting component and

permissibly including a thrust component is generated on said wing portion that

causes said apparatus to rise, and said control unit controls the extent to which

said apparatus rises in said surrounding fluid and also whether said apparatus

hovers or moves in said surrounding fluid,

wherein an angle of attack of said wing portion is smaller by virtue of the elastic

deformation of said wing portion than an angle of attack of a similarly controlled

rigid wing portion.

2. (Previously Presented) The rising and moving apparatus according to claim 1, wherein

said wing portion has an upper side and a lower side, said upper side having a greater

torsional rigidity or flexural rigidity than a torsional rigidity or flexural rigidity

of said lower side .

3. (Previously Presented) The rising and moving apparatus according to claim 1, wherein

said wing portion has a leading edge and a trailing edge, said leading edge having a

greater torsional rigidity or flexural rigidity than a torsional rigidity or flexural

rigidity of said trailing edge.

4. (Previously Presented) The rising and moving apparatus according to claim 1, wherein
said wing portion has an upper surface and extends outwardly from said body in a span
direction, said upper surface of said wing portion defining a wave plate structure
comprising alternating ridge lines and valley lines extending along said span
direction of the wing portion .
5. (Previously Presented) The rising and moving apparatus according to claim 1, wherein
said wing portion includes a leading edge portion and extends outwardly from said body
in a span direction, said leading edge portion defining a wave plate structure
comprising alternating ridge lines and valley lines extending along said span
direction of the wing portion .
6. (Previously Presented) The rising and moving apparatus according to claim 1, wherein
said wing portion includes an upper side portion comprising a self-supporting member or
a non-self-supporting member and an associated support structure, and a lower
side portion comprising a self-supporting member or a non-self-supporting
member and an associated support structure, and a thickness of the upper side
portion of said wing portion is larger than a thickness of the lower side portion
of said wing portion .
7. (Previously Presented) The rising and moving apparatus according to claim 1, wherein
said wing portion includes a front side portion comprising a self-supporting portion or a
non-self-supporting portion and an associated support structure and a trailing side
portion comprising a self-supporting portion or a non-self-supporting portion and
an associated support structure, and a thickness of the front side portion of said
wing portion is larger than a thickness of the trailing side portion of said wing
portion .

8. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion defines a first section adjacent to which a relative velocity of said surrounding fluid is high and a second section adjacent to which a relative velocity of said fluid is low, and an angle of attack of said first section of said wing portion to said surrounding fluid is smaller than an angle of attack to said surrounding fluid of said second section of said wing portion .
9. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion defines a tip end furthest from said body and a root substantially abutting said body, and an angle of attack to said fluid at said tip end is smaller than an angle of attack to said fluid at said root.
10. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion is rotatable about a prescribed center of rotation, and a flexural rigidity of a first section of said wing portion is greater than a flexural rigidity of a second section of said wing portion disposed further away from said prescribed center of rotation than said first section of said wing portion .
11. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion is rotatable about a prescribed center of rotation, said wing portion comprises a self-supporting member or a non-self-supporting member and a support structure, and a thickness of said wing portion at a first section thereof is greater than a thickness of a second section of said wing portion disposed further from said prescribed center of rotation than said first section of said wing portion .

12. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion is rotatable about a prescribed center of rotation and defines a first section and a second section, said second section being located further from said center of rotation than said first section, and a torsional rigidity of said first section is greater than a torsional rigidity of said second section .
13. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion defines a leading edge, a trailing edge, a span direction extending outwardly from said body and an axis of rotation located along said span direction of the wing portion such that said axis of rotation is positioned approximately midway between the leading edge and the trailing edge of the wing portion.
14. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion has a lower surface, said control unit controls said driving unit such that said wing portion pivots upwardly and downwardly relative to said body in upward and downward strokes and during transitions between said upward and downward strokes said lower surface of said wing comes into contact with an upper portion of a vortex generated by the motion of said wing portion immediately before said transitions

15. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion defines a curved upper surface having a first center of curvature and a curved lower surface having a second center of curvature, and said control unit controls said driving unit such that said wing portion pivots upwardly and downwardly relative to said body in upward and downward strokes such that elastic deformation of said wing portion occurs in a manner such that a direction of extension of an axis of rotation of a vortex generated during transitions between upward and downward strokes of said wing portion substantially matches a direction of extension of an axis connecting the centers of curvature of said upper and lower surfaces of said wing portion.
16. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion defines a root portion substantially adjacent to said body, and when said wing portion is driven by said driving unit, said root portion moves upwardly and downwardly relative to said body periodically, and said wing portion elastically deforms such that said wing portion defines sections that move upwardly and downwardly relative to said body out of phase with the movement of said root portion.
17. (Previously Presented) The rising and moving apparatus according to claim 16, wherein said wing portion defines an outer tip and said wing portion elastically deforms such that a phase of motion of sections located closer to said tip than said body where a relatively large fluid force is exerted is delayed relative to a phase of motion of sections of said wing portion closer to said body where a relatively small fluid force is exerted.

18. (Previously Presented) The rising and moving apparatus according to claim 17, wherein said delay in phase is at most $1/2$ of one period of said upward and downward motion of said section of said wing portion closer to said tip.
19. (Previously Presented) The rising and moving apparatus according to claim 16, wherein said wing portion elastically deforms such that a phase of the upward and downward motion of a tip end portion is delayed relative to a phase of the upward and downward motion of a root portion of said wing portion..
20. (Previously Presented) The rising and moving apparatus according to claim 19, wherein said delay in phase is at most $1/2$ of one period of said upward and downward motion of said root of said wing portion.
21. (Currently Amended) The rising and moving apparatus according to claim 1, wherein a manner of control of said control unit controlling said driving unit and a manner of elastic deformation of said wing portion are related such that a prescribed parameter of movement of said wing portion is determined ~~has the optimal value~~ in accordance with a result of fluid-structure interactive analysis.
22. (Currently Amended) The rising and moving apparatus according to claim 21, wherein the prescribed parameter related to movement of said wing portion ~~may be~~ is a lift force generated by the upward and downward motion of said wing portion relative to said body.

23. (Previously Presented) The rising and moving apparatus according to claim 21, wherein the prescribed parameter related to movement of said wing portion is a value obtained by dividing a lift force generated by the motion of said wing portion by a torque necessary for driving said wing portion so as to generate a desired lift force.

24. (Previously Presented) The rising and moving apparatus according to claim 21, wherein the prescribed parameter related to movement of said wing portion is the highest frequency of said driving unit necessary for realizing said optimum upward and downward motion of said wing portion.

25. (Previously Presented) The rising and moving apparatus according to claim 21, wherein the prescribed parameter related to the movement of said wing portion is a value obtained by dividing the lift force generated by the upward and downward motion of said wing portion by an energy necessary for generating the desired lift force.

26. (Original) The rising and moving apparatus according to claim 1, wherein said wing portion satisfies the following relation, where f denotes flapping frequency, L denotes representative length, r denotes a distance from a portion having the highest stiffness, w denotes a load on a portion at a distance r from the portion having the highest stiffness, and d denotes a displacement generated at the portion that bears the load w exerted by the load w :

$$0.36 \times 10^{-8} < r^3 \times w/d/(L \times f)^2 < 4.48 \times 10^{-8}.$$

27. (Original) The rising and moving apparatus according to claim 1, wherein said wing portion has Young's modulus of 1.77×10^8 to 5.66×10^9 .

28. (Original) The rising and moving apparatus according to claim 1, wherein said wing portion has Young's modulus of 2.5×10^8 to 2.0×10^9 .
29. (Original) The rising and moving apparatus according to claim 1, wherein said wing portion has Young's modulus of 1.77×10^8 to 2.0×10^9 .
30. (Previously Presented) The rising and moving apparatus according to claim 1, wherein said wing portion has an outer tip end portion and a root portion substantially adjacent to said body portion, and stiffness of a prescribed portion of said wing portion gradually increases from said tip end portion of said wing portion to said root portion of said wing portion, in proportion to a square of a distance from the tip end portion of said wing portion to said prescribed portion.
31. (Withdrawn) A method of manufacturing a rising and moving apparatus, comprising:
measuring step of measuring physical values related to an actual structure of a wing of an insect;
numerical value giving step of giving numerical values to the physical values related to the structure;
structural model preparing step of preparing an equivalent numerical model of wing structure that can be regarded as equivalent to said actual wing, using said physical value related to the structure given in numerical values;
model varying step of preparing numerical models of a plurality of different wing structures in which stiffness parameter of the equivalent numerical model wing structure is varied;
motion measuring step of measuring physical amounts related to manner of flapping motion while the actual wing of the insect is caused to perform flapping motion;
motion model preparing step of preparing a numerical model of flapping motion in which the physical values related to the manner of flapping motion are expressed as numerical values;

motion step of causing a plurality of different types of numerical models of wing structures to perform flapping motion represented by the numerical model of flapping motion, respectively, in preset virtual fluid for analysis;
analyzing step of calculating, in said motion step, a numerical model related to the fluid of the virtual fluid and the numerical model related to the structure of the numerical model of wing structure, respectively;

wherein

in said analyzing step, fluid-structure interactive analysis is used in which behavior of the fluid and behavior of the structure including interaction therebetween are analyzed;

said method further comprising

wing portion manufacturing step of manufacturing a wing portion that is driven by a driving apparatus, using said plurality of different types of numerical models of wing structure obtained through said analyzing step;

wherein

in said wing portion manufacturing step, a prescribed parameter of the numerical model related to the fluid of the virtual fluid and the numerical model of the structure of said numerical model of wing structure is extracted, and

said wing portion is manufactured using a numerical model of wing structure in which said prescribed parameter has an optimal value.

32. (Withdrawn) The method of manufacturing a rising and moving apparatus according to claim

31, wherein

said prescribed parameter is lift force generated at said numerical model of wing structure when said numerical model of wing structure is caused to perform said flapping motion.

33. (Withdrawn) The method of manufacturing a rising and moving apparatus according to claim 31, wherein

said prescribed parameter is a value obtained by dividing lift force generated at the numerical model of wing structure when said numerical model of wing structure is caused to perform flapping motion, by a torque necessary for driving said model of wing structure to generate the lift force.

34. (Withdrawn) The method of manufacturing a rising and moving apparatus according to claim 31, wherein

said prescribed parameter is maximum frequency of said driving unit necessary to cause said numerical model of wing structure to perform said flapping motion.

35. (Withdrawn) The method of manufacturing a rising and moving apparatus according to claim 31, wherein

said prescribed parameter is a value obtained by dividing lift force generated at the numerical model of wing structure when said numerical model of wing structure is caused to perform the flapping motion, by and energy necessary for generating the lift force

36. (Previously Presented) A rising and moving apparatus, comprising:

a body;

an elastically deformable wing portion associated with said body;

a driving unit for driving the wing portion; and

a control unit controlling the manner of driving the wing portion by the driving unit,

wherein

said control unit reciprocates said wing portion along a plane perpendicular to a direction of lift force generated by a flapping motion thereof for hovering and drives said wing portion in a different manner from a driving manner for hovering for moving said apparatus in a horizontal direction.

37. (Previously Presented) A rising and moving apparatus, comprising:

a body;

an elastically deformable wing portion associated with said body;

a driving unit for driving the wing portion; and

a control unit controlling the manner of driving the wing portion by the driving unit,

wherein

a lift force is generated on the wing portion of said rising and moving apparatus by elastic deformation of the wing portion.

Please add the following new claims to read as follows:

38 (New) The rising and moving apparatus according to claim 1, wherein
said driving unit includes a mechanism for making said wing portion reciprocate in a
substantially horizontal direction.

39. (New) The rising and moving apparatus according to claim 1, wherein
said driving unit includes a mechanism for making said angle of attack of said wing
portion actively change.